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(54) METHOD AND APPARATUS FOR GENERATING A LENS

(71) We, TEXTRON, INC., a corporation organized under the laws of the State of Delaware, United States of America, and having a place of business at 10, Dorrance Street, Providence, State of Rhode Island, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the manufacture of ophthalmic lenses, and more particularly to the blocking of lenses so that they can be chucked in the machines for generating and polishing their surfaces and for edge grinding them.

In the conventional processes for manufacturing an ophthalmic lens, a lens blank of molded glass or plastic is ground and polished on each of its two sides successively and then is ground on its perimeter or edge. Usually one side is concave and the other convex; and the two surfaces have different curvatures so that the thickness of the lens varies at different points. The shapes and spacial relation of the two surfaces determine the desired optical refraction.

In the grinding and polishing operations, the blank is normally secured to a lens block. The lens block may be of the permanent hard metal type or of the low melting point metal type block which is molded to the lens. The hard metal block is generally secured to the lens blank by means of an adhesive such as molten pitch or by a low melting point alloy. The lens block serves as a means to chuck the lens in the grinding and polishing machines.

Regardless of which block type is used, it usually must be removed for edge grinding the lens and substituted with another block of smaller diameter for this purpose. The block for holding the lens blank during surfacing has to be large enough to back up the glass or plastic lens to avoid breakage, while the block used for holding the lens blank during edging generally has to be small enough to clear the grinding wheel during the edge grinding operation.

In order for the lens to have the desired ophthalmic properties the unfinished side of the semi-finished lens must bear an exact and precise relation to the first finished surface of the blank which is mounted by the lens block. The precise location of the second surface with respect to the first may require either or both of two adjustments or settings, one called "axis" and the other called "prism". Setting for the axis or cylindrical axis involves a rotation of the second surface with respect to the first, and setting for prism involves a tilting of the second surface with respect to the first. Adjustment for prism, as well as for axis, may be achieved in the blocking operation if so desired.

When the permanent or hard metal type block is employed, the setting for axis is accomplished by orienting or rotating the block about the optical vertex or center of the lens. However the setting for prism is generally incorporated in the grinding machine chuck.

When the soft low melting point lens block is used, both of these settings are generally incorporated in the block mold before the block is molded. Thus the desired prism and axis settings to be imparted to the lens are incorporated in the block itself.

The soft metal block is manufactured by a lens blocking apparatus which has a mold cavity therein. The lens blank is positioned on top of the mold and a heated low melting point alloy is flowed into the mold on one side of the lens blank, and is then allowed to cool adhering itself to the blank. This type

of apparatus employs an annular seal or seat about the mouth of the mold upon which the finished surface of the lens blank is seated. The desired amount of prism is incorporated into the mold cavity by tilting the lens seat. The bottom of the mold cavity is provided with a rotatable piston having diametrically arranged pins projecting into the cavity which form bearing recesses in the molded block for chucking the same in cylindrical and spherical generating machines.

The lens is seated on the annular seat such that its ocular vertex or center, as prescribed, is centered over the central pin in the bottom of the mold cavity. The bearing point formed by the center pin is utilized for the transmission of spherical grinding forces.

Molten metal is supplied from a hopper into the lens block mold to fill the mold cavity. Means is provided for flowing water or other coolants around the mold when the pouring operation is completed to solidify the molten metal. The rotatable piston is then urged upwardly breaking the molded block away from the mold cavity.

Regardless of which lens block type is employed, the lens edge will overhand the perimetric edge of the block. This may be accentuated at some portions of the overhanging edge more so than at others because the lens block by necessity must be centred over the ocular center of the lens rather than the mechanical center of the lens. During surfacing or grinding of the mounted lens the overhanging lens portion is flexed or warped repeatedly due to the fact that no backup surface is provided. This causes the lens to be driven into the perimetric hard edge of the block thereby forming a permanent ring on the finished surface of the lens which renders it useless. This is found to be more common with the plastic lens which has greater flexing qualities than does the glass lens blank.

Flexing of the lens overhang causes the lens to become warped all the way into the center of the lens due to the flexing about the fulcrum point set up by the perimeter of the lens block. As a result the lens is distorted and its molecular structure is broken down rendering it useless.

Others have tried to solve this problem by using a larger lens block which covered practically the entire area of the finished lens surface. The block was secured to the lens with an epoxy which proved to be messy and time-consuming and therefore not desirable or practical from a laboratory standpoint.

The solution to the problem has also been sought by edging or grinding off the lens edge before the surface grinding and polishing operation are initiated. However prior to the present invention this required that an edging block be applied to the lens blank before the lens block for generating and polishing is applied. This consumes valuable time, and requires the application of an edging block, not only after polishing of the lens, but also before.

Our co-pending application No. 57340/69 (Serial No. 1,208,944) relates to an apparatus for making a lens block including a mold having a cavity open at its upper end and adapted to receive a supply of molten blocking material, means for supporting a lens blank sealingly over the upper end of the mold in spaced relation to the bottom of the mold, and in position to have said molten material adhere thereto as a block upon cooling, a pair of spaced, parallel pins projecting upwardly from the bottom of said mold into said cavity, and a first member mounted in the bottom of said mold for axial reciprocation into and out of said cavity to eject a molded block therefrom, wherein reference means project into said cavity in a plane that extends parallel to the axis of the cavity to form a corresponding reference surface on the block molded therein, and a second member is rotatably mounted in the bottom of said mold to adjust the angular position of said reference means relative to said pins about said axis of said cavity.

In addition our co-pending application No. 57341/69 (Serial No. 1,208,945) describes a method of generating a lens to prescription, comprising molding a lens block to a lens blank with the block mounted centrally with reference to a prescribed optical center on the blank, and with at least one reference surface formed on the block to define a reference line positioned parallel to the horizontal layout line of the blank, grinding away the excessive edge of the blocked lens blank with reference to said optical center and horizontal layout line, generating the blocked lens blank to the desired ophthalmic prescription while using the same lens block, and further grinding the edge of the blank to a finished shape with reference to the mechanical center of the prescribed lens.

Our further co-pending application No. 57342/69 (Serial No. 1,208,946) also relates to the production of lenses and discloses a method of generating a lens comprising the steps of applying one end of a shield plug to the ocular vertex surface area on the lens opposite the surface to be generated, mounting the lens on a block, which surrounds the plug to support the lens while generating, and which has an opening therethrough to expose the plug, generating the lens surface opposite that of the shield plug, and removing the shield plug to check the ophthalmic properties of the lens before removing the block.

According to this invention, there is provided a lens block adapted to be secured at one end to a lens blank, said block having in its opposite end a plurality of spaced recesses, which extend in the direction of the

axis of said block, for receiving driving members of a machine for generating a surface of a lens blank secured to the block, one of said recesses being disposed centrally of the block, wherein reference means are provided on said block for locating said block in a predetermined position on the spindle of an edge grinding machine, said means being spaced from said recesses and defining a plane which also extends in the direction of said axis.

The lens block used for lens grinding and polishing is provided with indexed chucking means or reference surfaces which permit the mounted lens to be chucked relative to the lens horizontal layout line in an edge grinding machine. The reference surfaces may consist fo a flat surface, notches or the like, in the perimetric edge of the block or small recesses or projections located adjacent the axial center of the face of the block. The lens is blocked such that its horizontal layout line is positioned parallel with the reference surfaces or at a known angle therewith.

Instead of chucking the blocked lens directly in the edge grinding machine, an adapter may be mounted on the block in mating engagement with the reference surfaces and provided with a smaller edging block to be chucked in conventional edging machines using a small chuck.

A hard metal or permanent lens block may be employed in the method of generating a lens as taught by the present invention wherein the lens edge is ground before generation and polishing. However the excess lens edge may be ground only to the block perimeter. When the soft, low melting point type metal block is used, the overhanging lens edge may be reduced beyond the perimetric edge of the block as the soft metal of the molded block is easily removed by the edge grinding machine along with the excessive glass or plastic. In either instance, the time required to generate and polish the lens is reduced as there is less lens surface area to work with and the lens will not be damaged from repeated flexing.

Since the lens block is centered with respect to the optical center of the lens, the preliminary lens edging is by necessity performed with this center as the reference rather than the mechanical center of the lens as is required for finish edging the lens to fit the lens frame in conformity with the prescription. Thus the lens edge which is preliminarily removed may be taken off in amount and shape close to that of the finished lens for example within 4 mm of the desired finished edge, but no further. Otherwise, when the polished lens is reblocked for edge grinding in accordance with a template shape generated about a different lens center, it would be discovered that too much lens edge had already been removed along portions of the lens edge and the lens would have to be discarded.

When the soft melting point metal type block is employed, the lens blocking apparatus of the present invention provides the indexed chucking means on the block to permit the mounted lens to be chucked relative to its horizontal layout line for edge grinding. In one embodiment the mold cavity is provided with fixed reference surfaces on its side walls. These reference surfaces may be in the form of diametrically opposed wedges in the mold cavity, or a flat surface forming a cord section may be used in the circular mold cavity to form one of the desired reference surfaces on the lens block. The lens blank is seated on the mold and oriented such that its horizontal layout line intersects or is parallel with the line of reference provided by the fixed reference surfaces on the walls of the cavity. The piston is then rotated in the bottom of the mold cavity to provide the proper cylindrical axis setting by rotating the diametrically aligned pins thereon which form the bearing recesses in the molded block.

Another structural variation of the lens blocking apparatus of the present invention provides centrally located pins, or similar means in the bottom of the mold cavity to form indexed chucking surfaces, which remain stationary while the perimetral portion of the piston retaining the pins is permitted to rotate thereabout to form the outside cylindrical bearing recesses.

Thus a collar is received in the bottom of the mold cavity for axial rotation, and a cylinder or disc-shaped member is received within the collar, and is fixed against axial rotation but permits the surrounding collar to rotate. Means to provide bearing points on the finished lens block for the transmission of cylinder generating forces to the lens is provided on the collar. Thus the collar may be rotated to align this means with the cylindrical axis of the lens. Another means is provided on the surface of the inner cylinder to provide a centrally located mount on the finished lens block for mating with a lens edging chuck.

The inner cylinder may also be provided with a central pin projecting axially into the mold cavity to provide a central bearing recess in the molded block to receive transmission of spherical generating forces from a generating or polishing machine. Instead of this central pin, the inner cylinder may be provided with a centrally axially aligned recess to receive the stem of an inverted shield plug of the type which forms a window in the center of the molded block.

The use of the window is important for glass lenses, since they may be made within closer tolerances; and where plastic lenses are concerned, it is difficult to accurately grind and polish the lens without checking the

prescription. This invention permits such checking through registered windows not only in the low melting point material, but also in the permanent metal lens block without removing the same. Thus every correction can be made in the grinding and polishing steps to provide an accurate lens without loss. If these plastics lenses were to require mounting in the low melting point blocking metal after they have been ground or partially ground, they would become distorted and the time lost would be materially greater than the cost that could be afforded.

Thus it is possible to check the prescription of the lens before removing it from the permanent metal lens block and particularly so with plastics lenses.

Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is a bottom plan view of a lens mounted by a low melting point lens block incorporating the principles of the present invention.

Fig. 2 is a bottom plan view of a hard metal lens block mounted on a lens and incorporating the principles of the present invention;

Fig. 3 is a cross-sectional view in side elevation taken along line 3—3 of Fig. 2;

Fig. 4 is a perspective view of an adaptor having an edging block for mounting on the lens block of Fig. 1;

Fig. 5 is a view in perspective of an edging block adaptor illustrating another embodiment of the present invention;

Fig. 6 is a view in perspective of an edging block adaptor illustrating structural modifications of the adaptor shown in Fig. 5;

Fig. 7 is a plan view of the lens blocking apparatus of the present invention disclosing the interior of one type of mold cavity that may be employed with this apparatus;

Fig. 8 is a bottom plan view of a lens mounted by a lens block illustrating another embodiment of the lens block of the present invention;

Fig. 9 is a cross-sectional view in front elevation of the lens blocking apparatus of the present invention for the manufacture of the block shown in Fig. 8;

Fig. 10 is a bottom plan view of a hard metal block made in accordance with another embodiment of this invention, and having mounted thereon a lens;

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 10, and showing a removable plug in the block;

Fig. 12 is a top plan view of the lens engaging face of this block;

Fig. 13 is a bottom plan view of a different block of low melting point material secured on a lens;

Fig. 14 is a sectional view taken along the line 14—14 in Fig. 13 and illustrating the structure of Fig. 13 held by low pressure air on a mandrel for generating the lens;

Fig. 15 is a bottom plan view of a lens mounted on a still different block for rough and finish polishing a cylindrical and a spherical surface on the lens; and

Fig. 16 is a sectional view taken on the line 16—16 of Fig. 15.

The lens blocking apparatus of Fig. 9 comprises a base 20, the upper surface of which is designated at 21. Mounted in the base, and keyed against rotation thereto is a block mold 23. This mold is held against upward movement by a collar 24, which is fastened to the mold by screws, and which engages under the top wall of the base. Mounted to reciprocate in a counterbore 27 in the upper end of the mold is a piston or collar 28. The piston is of reduced diameter at its lower end; and the reduced diameter portion of the piston is adapted to slide in the guide bore 29 of the mold. The counterbore 27 communicates with the guide bore 29 at its lower end; and at its upper end communicates with the mold cavity 30 in the upper end of the mold. Guide bore 29 communicates at its lower end with the reduced diameter coaxial main bore of the mold. Secured in the upper end of the collar 28 are two pins 36. These pins are arranged diametrically of the collar and each has a pressed fit in the collar. These two end pins 36 are alike. Each has a truncated conical portion 39 seating against the upper face of the collar and projecting thereabove. Each has a domed shaped portion 40 above its conical portion 39.

The collar 28 is constantly urged upwardly by coil spring 45, which seats at its upper end in a recess in the bottom of the collar and which is interposed between the bottom of the collar and the base of a counterbore in the sleeve 46. Slidably received within the central opening of the collar 28 is a piston 48 having a piston rod 48′ of circular cross section extending through sleeve 46 in slidable engagement therewith. The sleeve 46 has an integral collar formed on it at its upper end which engages in guide bore 29 to prevent the sleeves from dropping out of the main bore of the mold. The sleeve is journaled in the main bore of the mold 23, and has a beveled gear 50 fastened to it at its lower end by a set screw 51.

The collar 28 is rotatable in the mold by means of a knurled knob 55 which is secured by means of a set screw to a shaft 56 that extends at right angles to the rod or shaft 48′. Shaft 56 has a beveled pinion 57 secured thereto by a set screw 59. The pinion 57 meshes with the beveled gear 50 that is keyed to sleeve 46. Pins 46′ are threadably secured ni the collar of the sleeve 46 and protrude upwardly into guide bore 29 where they are

slidably received within mating bores in the bottom of collar 28. Thus when knob 55 is turned sleeve 46 is rotated along with pins 46′ which cause collar 28 to rotate while permitting the same to slide axially. The piston 48 and rod 48′ are held against axial rotation by means of the boss 100 secured to the base 20 as indicated and providing the slide bore 101 having the key 102 projecting in sliding engagement into the groove 103 extending longitudinally in the rod 48′. The collar 47 is secured to the lower end of the rod 48′ by means of a set screw to prevent removal of the piston 48 and to limit its upper movement.

The upper face of the piston 48 exposed to the mold cavity 30, is provided with a central recess 104 to receive the stem of an inverted, resilient shield plug 17. Diametrically aligned with the center recess 104 are two pins 105 projecting into the mold cavity 30, to provide the chucking reference surfaces or recesses 19 in the molded block as shown in Fig. 8.

The restriction provided between the piston 48 and the rod 48′ provides an abutment or annular shoulder 106 which mates with a corresponding shoulder in the central opening of the collar 28 thereby preventing the collar from being removed axially from the cavity 30 while collar 47 is secured to the bottom end of rod 48′.

The pins 36 are thus located angularly about the axis of the collar by turning knob 55. This determines the angular position which the molded lens block will occupy in the chuck of a lens manufacturing machine. In other words the angular position of the collar determines the cylindrical axis of the lens being manufactured.

In use a lens blank is seated upon the annular resilient seal or seat 64 encompassing the mouth of the mold cavity 30. The desired prism setting to be incorporated into the molded block is accomplished by tilting the seat 64. This means provided for tilting the seat 64 is conventional, and is therefore not herein described. It need only be said here that the annular ring or seat 64 can be tilted to any angle to adjust the blank for the desired amount of prism and prism axis by means of a cam rotatable about an axis disposed at right angles to the axis of the rod 48′.

For supplying the molten metal to the mold, a conventional hopper (not illustrated) is provided to receive chunks of metal alloy, including previously used lens blocks. The hopper has a heater secured to it for melting down the chunks of metal. The hopper is provided with a passage leading to the mold cavity 30 which may be opened and closed at will to fill the cavity with the molten metal.

Mounted directly on the molding apparatus in a conventional manner is a suitable sighting device (not illustrated) provided with an eye piece in a retical for aid in aligning the lens blank. This sighting device is aligned directly over the mold cavity 30 and is provided with resilient prongs at its lower end which may be lowered in engagement with the lens blank to maintain the same against the seat 64. The operation of the sighting device and hopper along with their associated parts are conventional.

To maintain the mold cool during the casting operation, and to harden the molten metal in the mold cavity 30, thereby forming the lens block, the mold is provided with peripheral grooves 78 around it at its top portion, and water or other suitable coolant is supplied to these grooves by a conduit which is connected with the collar 24.

After the molded block has cooled, the block is stripped from the mold cavity by forcing the rod 48′ upwardly, thereby pushing the piston 48 upwardly. The piston 48 is followed by the collar 28 which is urged upwardly by the coil spring 45. The rod 48 is moved upwardly by manual operation of a lever 90, which is secured to a shaft 91 that is journaled in the base of the machine. This shaft has a cam 92 pinned to it which is positioned to engage the lower end of the rod 48′. A coil spring 95, which surrounds the shaft 91 and which is engaged at one end in the lever arm 90 and at its opposite end in the base 20, serves to urge the shaft constantly to its inoperative position where the cam 92 is out of engagement with the rod 48 as indicated in the drawings. A pin 93 is secured to the cam and adapted to engage against the lug 94 in the base to limit the return movement of the shaft 91.

To briefly sum up the operation of the apparatus, the operator seats the shank of a shield plug 17 into the central recess 104 of the piston 48. A lens blank is then seated on the seat or ring 64 and the operator sights through the sighting device to locate the ocular centre of the lens over the center of the mold. The lens is also positioned such that its horizontal layout line intersects both of the pins 105. The ocular vertex surface area of the lens being in engagement with the plug 17 forces the piston 48 downwardly along with collar 28. Good sealing engagement is provided between the ocular vertex area of the lens and the upturned face of the resilient shield plug 17 by means of the constant urging imparted by coil spring 45. The operator then adjusts collar 28 rotatably by turning knurled knob 55, pinion 57 and gear 50 while sighting through the eyepiece to position the pins 36 for the desired cylindrical axis. He also adjusts the prism axis by rotating the aforementioned cam (not shown) until the upper surface of the lens blank has the proper tilt for its desired prism. The sighting device

is adjusted downwardly until the resilient prongs clamp the lens blank on the annular seat 64. The molten metal is then permitted to flow up the mold cavity 30. When the mold cavity is filled with the molten metal the flow is stopped and the molten metal is permitted to harden. The sighting device is raised from the lens surface and the lever 90 is moved to cause cam 92 to force piston 48 upwardly to strip from the mold the molded block together with its plug 17 and the blank secured thereto. The blocked lens is then ready to be chucked in an edge grinding machine for removal of the excessive lens edge overhanging the block in accordance with a desired template shape.

Fig. 8 illustrates a block molded to a lens blank by apparatus of the type described above, and comprising a cylindrical head portion 1, and a frusto-conical shank portion 2. The openings 6 formed in the bottom of the block by pins 36 are used for cylindrical generation of the attached lens blank; and the openings 19 formed by pins 105 are used to chuck the block in an edge grinding machine to remove excess lens edge overhang. For generation of the lens, the shield plug 17 of Fig. 8 is removed and replaced by a shield plug 17′ of the type shown in Fig. 3, which plug is provided with the central bearing insert 8 for spherical generation of the lens. The shield plug 17 or 17′ may be removed during the grinding and polishing operations to determine with a vertometer whether the lens has acquired the desired ophthalmic properties.

Fig. 7 is a plan view of a modified form of mold cavity 30′, which may be used with the apparatus of Fig. 9. In this embodiment the cavity 30′ has diametrically opposed projections 3′ instead of the pins 105 for forming chucking surfaces on a molded lens block.

In use a lens is seated on the annular seat or seal 64 encompassing the mouth of the mold cavity 30′ so that the optical center of the lens is positioned over the center 5 of the mold. The lens horizontal layout line is then aligned with the reference surfaces 3′ and the pins 36 which are secured to the piston 28. At this time the pins 36, which provide the cylindrical axis bearing points on the molded block, are located at an axis setting of 0° from the horizontal. The piston 28 is then rotated to provide the desired axis setting. After the hot molten metal has been introduced into the mold 30′ and has been permitted to solidify the block lens is removed by urging the piston 48 upwardly.

A lens block made in accordance with this embodiment is shown in Fig. 1 of the drawings, and for example, is made from soft metal molded on the exterior surface of the lens, which may be first coated with plastic material or a tape. The lens illustrated may be a glass lens or a lens molded of plastic material. The lens block is provided with a cylindrical head portion 1′, and a frusto-conical shank portion 2′ projecting upwardly (Fig. 1) therefrom and terminating in a circular flat surface that is normal to the axis of the lens block. Opposed perimetric notches 3 are provided in the frusto-conical shank portion 2′ in line with the centre of the lens block. The notches 3 provide indexed reference surfaces which locate the horizontal layout line of the lens block. When the lens block is poured with material of a low melting point, the notches 3 are formed by the surfaces 3′ on the side walls of the mold cavity as illustrated in Fig. 7.

The blocked lens of Fig. 1 may then be chucked in an edging machine chuck (not illustrated) provided with surfaces for mating engagement of the indexed reference surfaces 3. The lens is thereby chucked relative to its horizontal layout line and its overhanging or overlapping edge may be removed in accordance with a desired final shape of the lens as indicated by the dashed line 9. However, since the lens block is centred over the optical center of the lens rather than its mechanical center, the edge portion may not be removed to the desired final or finished shape 9. Otherwise, when the polished lens is reblocked for final edge grinding in accordance with the lens frame opening, it will be discovered that too much of the lens edge has already been removed. Therefore the overhanging portion is generally ground down to within, for example, 4 milimeters of the finished shape 9.

As indicated at 10 on the figure, portions of the soft metal block may be removed along with the lens edge to give the desired shape. However, when the hard metal type block is employed, as shown for example in Fig. 2, the lens edge may not be removed beyond the perimetral edge of the head portion of the block.

Conventional edge grinding machines are usually provided with a chuck of smaller diameter than the lens block. However, the block of Fig. 1 may be readily adapted to be received in such a chuck. An adaptor for this purpose is illustrated in Fig. 4, wherein a small edging block 18 is provided with the reference wedges 3′ for mating engagement with the reference surfaces 3 of the lens block of Fig. 1. Thus when the adaptor of Fig. 4 is mounted on the lens block the projections 19′ of the edging block 18 are properly aligned with the lens layout line. This is due to the fact that projections 19′ are aligned with the wedge points formed by the reference surfaces 3′.

Instead of molding to the lens blanks the one-piece, soft metal blocks (Figs. 1 and 8), which are used only once and are then remelted or otherwise destroyed upon removing

the finished lens blanks therefrom, it may be desirable to employ permanent, or hard metal blocks of the type shown in Figs. 2, 3 and 10 to 16.

The two-piece hard metal block of Figs. 2 and 3 is generally provided with the same structural features of the block shown in Fig. 1, including the usual cylindrical head portion 1″. The frusto-conical shank portion 2″, however, is formed on the outside of a movable collar 11, which is rotatable on the outside of, and is slidably engaged with, a reduced diameter, cylindrical surface 12 on head portion 1″ of the block. The surface 12 has an annular groove 13 therearound to receive the tip of a set screw 14 threadably engaged with and passing through the collar 11. This particular hard metal block is provided with a central opening 16 which receives a resilient shield plug 17′, which exposes the ocular vertex area of the lens when removed, and seals the same when inserted. A central bearing member 8 is vulcanized into the shield plug 17′.

Once the lens and lens block have been oriented with respect to each other for axis on conventional blocking apparatus (not illustrated), a molten alloy is poured into the opening 15 (Fig. 2), and flows into the space formed beneath the lens blank by spaced projections 32 on the upper face (Fig. 3) of head portion 1″, thereby to seat and secure the block to the lens with the series of inserts 6′ and 8 aligned with the prescription cylindrical axis of the lens. The collar 11 is thereafter rotated and locked such that a reference surface 33 thereon is parallel to the horizontal layout line of the lens. The reference surface 33 may therefore be aligned with the horizontal layout line by mounting the blocked lens in a vertometer, whereby the properties of the lens may be determined by viewing through the window provided by the opening 16, and rotating the main portion of the block relative to collar 11.

Again this hard metal block may be chucked directly in an edge grinding machine by an adaptor such as that shown in Fig. 5. The adaptor of Fig. 5 is provided with an edging block 18′ having the diametrically opposed recesses 19 at its outer ends to receive mating pins of an edge grinding chuck. The frusto-conical side wall 32′ of the adaptor is provided to mate the frusto-conical shank portion 2″ of the lens block of Figs. 2 and 3, while the flat side wall 33′ is adapted to mate with the reference-surface 33 of the hard metal block. The surface 33′ properly aligns the edging block 18′ with the horizontal layout line of the lens as the block 18′ and the recesses 19 are aligned in parallel with the surface 33′ and the lens horizontal layout line.

The lens block as gripped by the adaptor of Fig. 5 is maintained in the edge grinding chuck by a resilient backup surface pushing on the unfinished lens surface.

The adaptor of Fig. 6 eliminates the frusto-conical wall 32′ of the adaptor as shown in Fig. 5 and substitutes therefor a central resilient plug 117 to be received in mating engagement with the central opening 16 of the hard metal block. The edging chuck 18 of Fig. 6 is similar to that employed by the adaptor shown in Fig. 4.

Referring now to Figs. 10, 11 and 12 of the drawings, a modified hard metal lens block 61 is secured to a lens by means of an adhesive 22 so that the lens may be chucked in the grinding and polishing machines. The adhesive may consist of a molten low melting-point pitch, resin or alloy, and for example, may be a mixture of bismuth, lead, tin, indium and cadmium which has a melting point of about 136 degrees F. The lens may be first coated with a protective finish such as with a sprayed plastic or a tape to prevent the convex finished surface 63 of the lens blank from becoming scored or otherwise damaged, and to provide better adherence of the low melting-point material to surface 63.

The block 61 is oriented on conventional apparatus relative to the lens to provide the proper adjustments for axis in order for the lens to have the ophthalmic properties desired; and the molten low melting-point material is then introduced therebetween by way of the mold entrance or fill passage 4 through the block 61. The molten material fills the cavity between the surface 63 of the lens and the upper face 5 (Fig. 12) of the block, where it solidifies and fixes the hard metal block 61 to the lens with the proper axis adjustment. The upper face 5 of the block is provided with the projections 62 to permit evacuation of air pockets and facilitate adhesion of the block with the pitch or low-melting alloy.

The lens block 61 is provided with the head portion 67 having a frusto-conical shank portion 68 projecting downwardly therefrom and terminating in a circular flat surface 10′ that is normal to the axis of the lens block 61. The block 61 is provided with flat gauge surface 111 which is parallel to the axis of cylindrical generation or the line of the three recesses in the outer ends of the inserts 6′ and 8′ to provide a reference point so that the cylindrical axis of the lens is known at all times while the lens is blocked. This flat 111 thus permits the cylindrical axis of generation to be automatically located on a vertometer and permits a rough check of the lens prism while the lens block is still on the lens.

The face 10′ of the block is provided with an aligned series of three inserts 6′, 8′ and 6′, respectively. The two recesses or bearing surfaces in the inserts 6′ are adapted to

accommodate two driving pins of the spindle or arbor of a generating or cylinder surfacing machine; and the recess or bearing surface in insert 8′ is adapted to receive the driving pin of a sphere surfacer when a spherical surface is to be ground on the blocked lens. The inserts 6′ are formed of metal that is somewhat harder than that of the hard metal block 61, such as steel or brass, to provide a good bearing surface. These inserts are pressed into the block 61 wherein they are rigidly sealed and fixed. Access to the under side of the inserts 6′ is provided from the surface 5 to permit their removal and replacement.

The block 61 has a central hole or opening 16 therethrough to receive the shield plug 17″ and provide a window for the block that is mounted on the lens. The shield plug 17″ is preferably of a somewhat elastomeric material such as rubber or a plastic to provide a good seal when the plug is inserted in the opening 16. The plug extends beyond the surface 5 of the block and engages the convex surface 63 of the lens to seal off the ocular vertex surface area of the lens before the low melting-point material 22 is poured into the cavity between the block and lens. The inner end 41 of the plug is preferably concave to ensure that the ocular vertex area of the lens is well sealed from the molten adhesive. Thus the block 61 is properly adjusted in relation to the lens for axis and the ocular vertex area is sealed off before the molten material is introduced through passage 4. When the molten material has solidified, the shield plug 17″ may be removed to provide access to the ocular vertex area of the lens through the block 61 and low melting-point material 22.

The shield plug has therein a hard metal insert 8′, which is vulcanized or otherwise secured to the plug, as by molding or gluing irregular projections of the insert 8′ within the plug, and which provides a bearing recess for spherical generation or polishing, and a means to grip and remove the shield plug. It is preferable that a small clearance 26 be provided between the flanged outer end of insert 8′ and the block surface 10′ to take advantage of the shock absorbing properties of the shield plug 17″ during the spherical grinding operations when the grinding forces are transmitted to the bearing recess.

The lens may then be generated to prescription with the shield plug 17″ inserted to seal the ocular vertex area on the finished surface 63 of the lens thereby protecting it from being damaged by abrasives during the operation of generating and polishing the lens. During any period of generation or polishing, the block mounted lens may be removed from the grinding machinery and the plug 17″ removed to permit the power and the prism to be checked for accuracy and reground and polished, if necessary, after the shield plug is replaced, and without disturbing the original lens block. This not only saves time in the process of generating and polishing the lenses but permits one to very accurately reproduce the prescription with the use of only one lens block application. This also prevents waste caused from an overgeneration of the lens which cannot be corrected thereby rendering the lens useless. This is particularly true with plastic lenses which due to their unpredictable properties make it extremely difficult to generate an accurate prescription without the means of the present invention to periodically check the lens prescription with a vertometer before dismantling the lens block 61 and the material 62.

The hard metal block 61 has a circumferential groove in the wall of the opening 16 to provide an interlock 9′ with a corresponding annular shoulder or projection formed on the shield plug 16. This interlock prevents accidental removal of the shield plug.

Referring to Figs. 13, 14, 15 and 16, the lens is mounted on the low melting-point material 22′ which forms a thin molded lens block in itself. This thin block may be molded thereon by a conventional machine. The low melting-point alloy is molded to provide the smooth dome-shaped surface 81 with the ring 82. The ring 82 has a projecting key 83 which orients the block insofar as the cylindrical axis is concerned, when the lens is chucked for primary or rough generation by the vacuum chuck 84 as shown in Fig. 14, and for final generation on block 44 as shown in Figs. 15 and 16.

The shield plug 85 is inserted in the mold of the blocking machine before the thin lens block 22′ is molded so that the block will be accurately molded around the shield plug. A projection of the low melting-point material as indicated at 86 aids in sealing and retaining the plug in the window on the ocular vertex surface area of the lens.

The structure of Figs. 13, 14, 15 and 16 is primarily used with plastics lenses. The block 22′ is thin to provide quick dissipation of heat during the primary rough generation of the lens while it is being held in the vacuum chuck 84. The cavity between the smooth dome surface 81 of the block and the inside surface 87 of the chuck 84 is sealed by the O-ring 89, and is under vacuum by way of passage 88. Relief grooves 70 are provided on the smooth dome surface 81 to ensure uniform negative pressure throughout the cavity between surfaces 81 and 87. The stem 71 axially connected to the chuck 84 provides a means to support the chuck in the generating machine. The thinness of the block 22′ and the constant removal of air through passage 88 ensures that the plastics lens will not be damaged by overheating.

When the lens has been rough generated

and is ready for fine cylindrical and spherical generation, the chuck 84 and plug 85 are removed, and the hard metal block 44 as shown in Figures 15 and 16, is seated over the low melting-point block 22′ with a fairly precise fit. The block 44 contains a removable plug 17′, and the aligned series of bearing recesses in its inserts 42 and 8 are automatically positioned in line with the cylinder axis of the lens. The molded key 83, which has already been thus oriented before molding of the block 22′, is received with precision by a recess 43 in block or adaptor 44. Similarly, during rough generation of the lens, the lens is properly positioned by key 83 as shown in Figure 14.

When the block 44 is seated on alloy block 22′, and plug 17′ is removed, the blocked lens may be seated in the vertometer mount with the proper alignment with respect to the cylinder axis as indicated by the gauge surface 111′ (Figure 15) to check the lens against the prescription by viewing through the ocular vertex area exposed by the opening 16. If desired, the dome surface 81 and shoulder or ring surface 82 may be coated with an adhesive to ensure engagement of the block 44 on the low melting alloy block 22′.

The shield plug 17′ has the extension 66 (Figure 16) beyond surface 10′ to provide a means of gripping and removing the plug. It is obvious that the reference means provided by the surfaces 33, 111 and 111′ may be of a different design. For example, V-shaped notches may instead be provided in the perimeter of the block to provide reference surfaces.

The present invention provides a lens block which may be used not only for generating and polishing the lens, but it also provides a block for edge-grinding the lens before the operations of generating and polishing are initiated and thereby makes possible a new method of generating a lens whereby the excessive lens edge is removed before generating and polishing the lens by using the same lens block. Removal of the excessive lens edge overhanging the lens block prevents lens warping and flexing thereby saving additional manufacturing time, cost and material.

WHAT WE CLAIM IS:—

1. A lens block adapted to be secured at one end to a lens blank, said block having in its opposite end a plurality of spaced recesses, which extend in the direction of the axis of said block, for receiving driving members of a machine for generating a surface of a lens blank secured to the block, one of said recesses being disposed centrally of the block, wherein reference means are provided on said block for locating said block in a predetermined position on the spindle of an edge grinding machine, said means being spaced from said recesses and defining a plane which also extends in the direction of said axis.

2. A lens block as defined in claim 1, wherein said reference means comprises two identical notches formed in the perimeter of said block at diametrally opposite sides thereof, the centers of said notches being disposed in said plane.

3. A lens block as defined in claim 1, wherein said reference means comprises two identical holes formed in said opposite end of said block at diametrally opposite sides of said center recess, the axes of said holes lying in said plane.

4. A lens block as defined in claim 1, wherein said reference means comprises a plane chordal surface formed on the perimeter of the block and lying in the first-named plane.

5. A lens block as defined in claim 4, wherein said lens block has on said one end thereof a plurality of spaced projections engageable with a lens blank to support the blank in slightly spaced relation to said one end of the block, and said block has therethrough a hole spaced from said recesses for supplying a molten alloy to the space between said blank and said one end of the block to secure the blank to the block.

6. A lens block as defined in claim 5, wherein said block comprises two members, one of which has a head portion and a reduced diameter shank portion, said projections are on said head portion and said recesses are in said shank portion, the other member is a ring rotatably adjustably mounted on said shank portion coaxially of said central recess, and said plane, chordal surface is formed on the outer peripheral surface of said ring.

7. A lens block as defined in claim 4, wherein said block comprises two members, one of which is adapted to be secured at one end to a lens blank, and the other of which is secured to the opposite end of said one member, said members having confronting surfaces, one of which has thereon adjacent its marginal edge a projection which seats in a cooperating recess in the other of said confronting surfaces, and said plane, chordal surface is formed on the perimeter of said other member.

8. A lens block as defined in any one of the preceding claims, wherein a resilient plug is releasably mounted in a central hole in the block for engagement at one end thereof with a lens blank, when the latter is secured to the block.

9. The combination with a lens block as defined in claim 1, of an adaptor mounted on said opposite end of said block, said adaptor having at one end thereof reference means engaged with said reference means on said block to hold said adaptor in a predetermined angular position relative to said

block, and having at its opposite end means for releasably coupling the adaptor to an edge grinding machine spindle.

10. The combination as defined in Claim 9, wherein said reference means on the adaptor is a plane surface engageable with a corresponding surface on the block.

11. The combination as defined in Claim 9, wherein said reference means on the adaptor comprises two projections seated in corresponding notches formed in diametrally opposite sides of said block.

12. A lens block substantially as described herein with reference to Figures 1 to 13, 15 and 16 of the accompanying drawings.

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Fig. 1

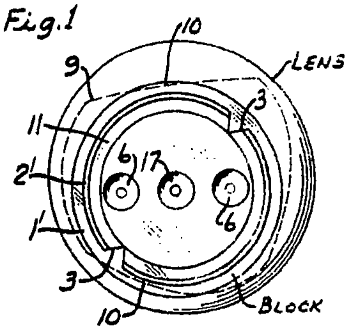

Fig. 2

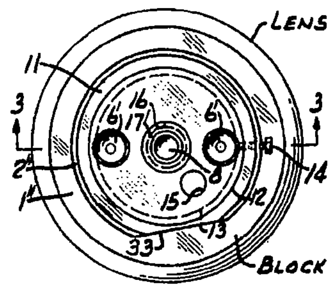

Fig. 3

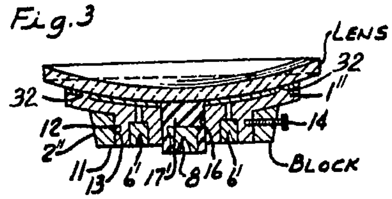

Fig. 4

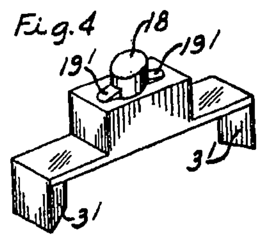

Fig. 5

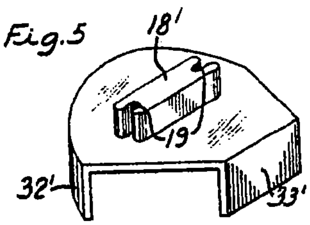

Fig. 6

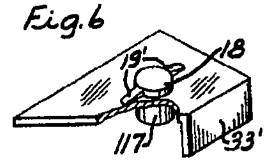

Fig. 7

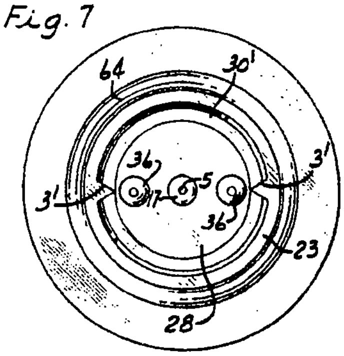

Fig. 8

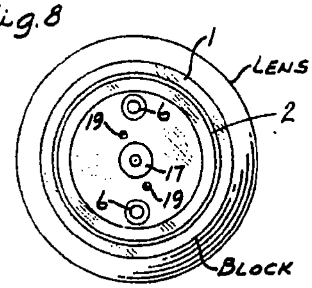

Fig. 9

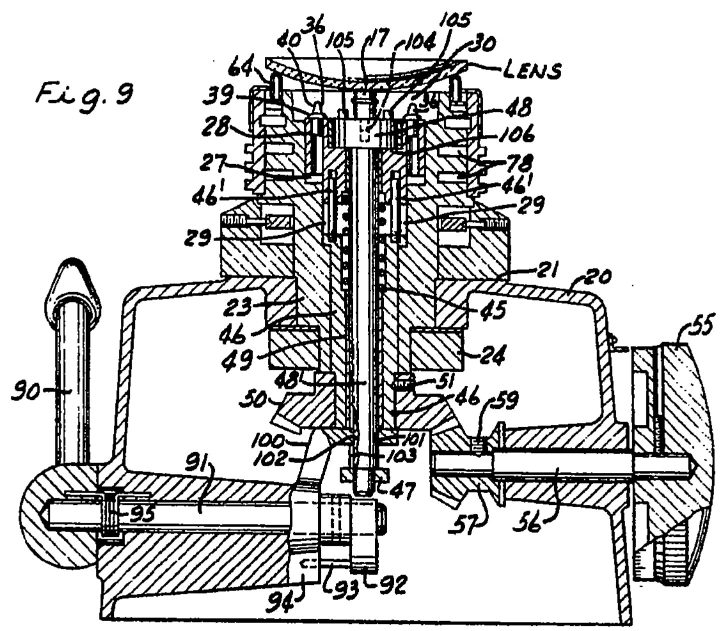

Fig. 10

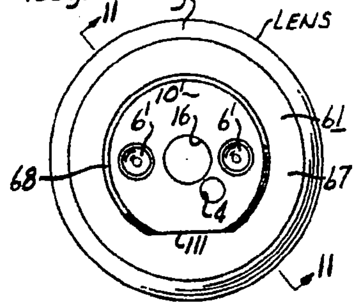

Fig. 11

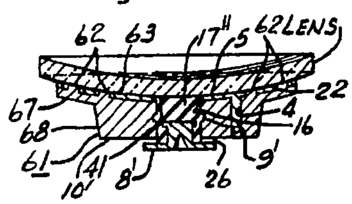

Fig. 12

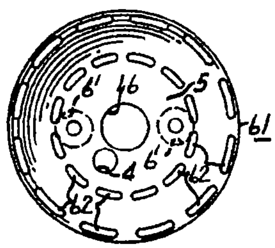

Fig. 13

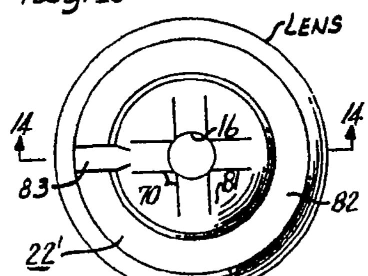

Fig. 14

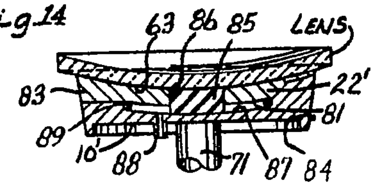

Fig. 15

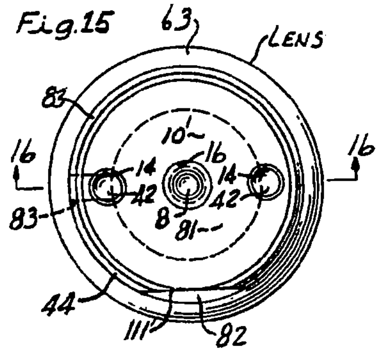

Fig. 16